

PROJECT facts

Virtual Power Plant Modeling and Simulation

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U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY



ADVANCED PROCESS ENGINEERING Co-SIMULATION

Description

At the National Energy Technology Laboratory (NETL), computational scientists and engineers build on strong collaborations with R&D technology partners and funding from Fossil Energy's Power Systems Advanced Research program, to develop the **Advanced Process Engineering Co-Simulator (APECS)**. APECS is an integration framework that combines steady-state process simulation with high-fidelity equipment models based on computational fluid dynamics (CFD). Winner of an R&D 100 Award in 2004, this powerful co-simulation technology is the first to provide the necessary level of detail and accuracy essential for engineers to better understand and optimize the fluid flow, heat and mass transfer, and chemical reactions that drive overall plant performance. Coupled with advanced visualization and high-performance computing, APECS offers opportunities for exploiting virtual plant simulation to reduce the time, cost, and technical risk of developing high-efficiency, zero-emission power plants.

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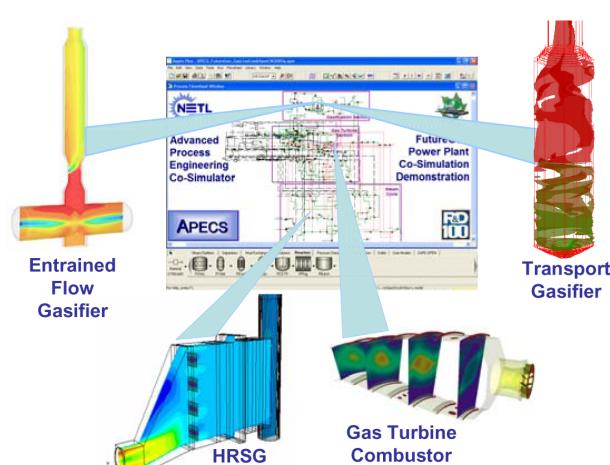
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WEBSITE

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FutureGen Power Plant Application

The U.S. Department of Energy's (DOE) \$1 billion FutureGen Research Initiative is aimed at creating the world's first coal-based, nearly emission-free electricity and hydrogen production power plant. The 275-megawatt FutureGen plant will employ advanced coal gasification technology integrated with combined cycle electricity generation, hydrogen production, and capture and sequestration of carbon dioxide. At NETL, system analysts are evaluating and optimizing potential FutureGen plant configurations using APECS co-simulations with detailed CFD models of key equipment items, such as gasifiers, gas turbines, heat recovery steam generators, and fuel cells.



APECS Co-Simulation of a FutureGen Power Plant



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SECA Fuel Cell Application

DOE is sponsoring development of cost-effective, high-volume, fuel cell power systems through its Solid State Energy Conversion Alliance (SECA) program. Auxiliary power units (APU) represent a large ready-market opportunity for solid oxide fuel cell systems for use in transportation applications. Ongoing research at NETL is addressing the need to analyze these systems for low cost, high efficiency, and maximum thermal integration. APECS can simulate the overall performance of APU systems to optimize local fluid flow, heat and mass transfer, electrochemical reactions, current transport, and the potential field of fuel cell stacks using detailed, three-dimensional, steady-state CFD models.

APECS Benefits

- Helps engineers to better understand and visualize the fluid flow behavior that impacts process design and operation.
- Considers detailed equipment models in the context of plant-wide simulations, with recycle loops, heat integration, and water management.
- Enables rigorous analysis and optimization of entire plants with respect to CFD-related equipment model parameters.
- Eliminates potential for suboptimal designs by using the same physical properties and reaction kinetics in the underlying equipment and process models.
- Speeds technology development by reducing pilot/demo-scale facility design time and operating campaigns.
- Offers opportunities to achieve the aggressive environmental, performance, and economic goals for high-efficiency, zero-emission power plants.

APECS Features

- *CAPE-OPEN* standard software allows for plug-and-play interoperability of unit operation models, physical properties, and reaction kinetics.
- *Configuration Wizard* prepares equipment models as CAPE-OPEN compliant models for use in process simulation.
- *Model Database* stores and manages equipment models, including CFD, custom, and fast reduced-order models (ROMs) based on previously-computed CFD solutions.
- *Model Selection GUI* displays equipment models from the database to associate with blocks instantiated on the process flowsheet.
- *Model Edit GUI* displays equipment model parameters and defines flexible and powerful solution strategies.
- *Integration Controller* uses a CAPE-OPEN COM/CORBA bridge to enable serial/parallel execution of high-fidelity equipment models on distributed heterogeneous computers.
- *CFD Viewer* displays, within the process simulator, the results of CFD simulations conducted as a part of a co-simulation.
- *Analysis Tools* provide design specifications, case studies, sensitivity analyses, and optimization.

